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GUIDELINES FOR NANOTECHNOLOGY RESEARCH

Definition of Nanotechnology

Nanotechnology involves work with naturally occurring or engineered materials at dimensions between 1 and 100 nanometers. A nanometer is one billionth of a meter (1 nanometer = 10^{-9} meter). Engineered nanomaterials are manufactured within nanoscale dimensions. Naturally occurring nanomaterials can result from the fine crushing of minerals or fume production condensate.

1. Types of Nanomaterials

- 1.1. Nanomaterials consist of three types of materials (particles, tubes, and films) in which at least one dimension of the material are within the nanoscale.
- 1.2. Nanotubes are carbon tubes that have a diameter of 1 to 2 nanometers and are measured in microns or micrometers in length.
- 1.3. Nanofilms, nanoplates, and nanowires have a thickness measured in nanometers and the other two dimensions that are measured in millimeters (or larger).
- 1.4. Commonly used materials include (2-10 nm) carbon titanium dioxide, copper, gold, iron and silver nanoparticles.
- 1.5. Quantum Dots are nano sized particles or crystals of semiconducting materials (e.g. cadmium selenide, zinc sulfide) that can be excited to fluoresce into bright colors in biological tissues enhancing imaging.

2. Notification of Environmental Health and Safety (EH&S) of Nanotechnology Work

- 2.1. All University of Pittsburgh researchers shall register all nanotechnology work with EH&S. Registration can be completed through the EH&S website at the following link, <http://www.ehs.pitt.edu/biological/workbook.html>.
- 2.2. The Agent Registration Workbook contains the following five sections, each requiring specific information for completion:
 - 2.2.1. Administrative – description of the nanotechnology project
 - 2.2.2. Laboratory – description of laboratory location and equipment where nanotechnology work occurs and description of the work (ex. plasma etch, lithography, etc.)
 - 2.2.3. Personnel – listing of research personnel working on nanotechnology project

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2.2.4. Biological Agents – complete if biological agents are being used in nanotech project.

2.2.5. Chemical Agents – listing of hazardous chemical agents being used.

2.3. Two main versions of the workbook have been developed: a macro-enabled version for the PC and a non-macro version for the Macintosh.

3. Routes of Occupational Exposure

3.1. Absorption – Certain nanomaterials can be absorbed through intact skin, eyes or mucous membranes.

3.1.1. Researchers are required to wear safety glasses and gloves (latex or nitrile) during all handling of nanomaterials.

3.1.2. Researchers are required to wear disposable Tyvek laboratory coats or cloth laboratory coats with disposable Tyvek or vinyl sleeves during all handling of nanomaterials.

3.1.3. Laboratory Attire guidelines must also be followed. Consult EH&S Guideline #03-001.

3.2. Ingestion – Nanomaterials can be ingested if proper handling procedures are not followed.

3.2.1. Eating, drinking, applying cosmetics, handling contact lenses is not permitted in the laboratory per University Guidelines

3.2.2. Laboratory personnel should remove PPE when work with nanoparticles is completed and wash their hands.

3.3. Inhalation – Nanomaterials can be introduced to the respiratory system via inhalation of airborne particles.

3.3.1. Nanomaterials should be handled in solution or as part of a substrate whenever possible to minimize risk of inhalation.

3.3.2. Whenever possible, work with nanomaterials should be handled within an exhausted containment device or enclosure.

3.3.3. Laboratory personnel should wear the appropriate respiratory protection when working with nanomaterials outside of primary containment devices.

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3.4. Injection – Nanomaterials can be introduced to the body via a needlestick.

- 3.4.1. Standard precautions should be followed when utilizing sharps with any nanomaterials.
- 3.4.2. EH&S recommends the use of Safety-Engineered Sharps devices during work with nanomaterials.

4. Guidelines for Handling Nanomaterials in University Laboratories

- 4.1. University Chemical Hygiene Plan (EH&S Guideline # 04-001, <http://www.ehs.pitt.edu/assets/docs/chem-hygiene-plan.pdf>.) provides applicable guidelines for working with chemicals and should be followed by all research personnel utilizing nanomaterials in addition to the guidelines listed in this section.
- 4.2. Principal Investigator (PI) is responsible for developing and reviewing safe work practices with research personnel working with nanomaterials or within the same laboratory area that nanomaterials are handled.
- 4.3. PI must create a Standard Operating Procedure (SOP) for research work involving nanomaterials. The SOP must be available to all research personnel working with nanomaterials or within the same laboratory area that nanomaterials are handled.
- 4.4. PI is responsible for maintaining Safety Data Sheets (SDS) for all nanomaterials to be available and kept up to date within the laboratory in which nanomaterials are stored and used.
- 4.5. All manipulations of nanomaterials should occur in a certified chemical fume hood, certified hard ducted biological safety cabinet (Class II, Type B2), glove bag, glove box or enclosed HEPA filtered glove box. Horizontal laminar flow hoods (with air flow directed toward worker) are NOT permitted to be used with nanomaterials. Recirculating biosafety cabinets (Type A cabinets) are NOT permitted to be used with nanomaterials.
- 4.6. Work with nanomaterials outside of an exhausted enclosure require researchers to wear a NIOSH-approved P-100 particulate respirator (annual EH&S approved fit-test is required).
- 4.7. Individuals wearing P-100 respiratory protection must be enrolled in the University of Pittsburgh Respiratory Protection Program. Information on the Respiratory Program is available at the following link, <http://www.ehs.pitt.edu/assets/docs/respiratory.pdf>
- 4.8. Nanomaterials should be handled while in solution or part of a substrate to minimize airborne release.

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4.9. All containers (primary, secondary, and tertiary if applicable) should be labeled with the full name of the nanomaterials (avoid abbreviations and acronyms). “Nano” should be used in the chemical name.

4.10. Sealed, secondary containers should be utilized to transport nanomaterials between laboratories and buildings.

4.11. Every effort should be made to prevent the release of nanomaterials into the environment. EH&S recommends the use of a sticky mat at the exit of lab spaces where nanomaterials are handled.

5. Guidelines for Disposal of Nanomaterials and Associated Hazard Waste Solutions

5.1. Since the toxicology and environmental fate of nanomaterials is still largely unknown, nanomaterial waste (solid and liquid materials) should be managed through the University's Chemical Waste program. Do not dispose of nanomaterial waste in the regular trash or down the drain.

5.2. All wastes must be collected in a sealable container that is compatible with the waste being collected. Waste containers must be kept closed except when actively adding waste.

5.3. Waste containers must be labeled with a completed, orange “Waste Chemicals” label immediately upon first adding waste to the container. Identify all chemical constituents on the label using the common chemical names. Do NOT use chemical abbreviations, structures, or formulas to identify nanomaterial wastes.

5.4. Contact EH&S at 412-624-9505 with any questions about how to handle nanomaterial wastes.

6. Guidelines for Nanomaterial Spill Clean-up

6.1. Secure area where spill occurred, restrict access to the area and notify others in the laboratory of the spill.

6.2. Dry nanomaterials should NOT be brushed or swept.

6.3. Spill cleanup should be done using a wet wipe method and/or HEPA-filtered vacuum.

6.4. Appropriate PPE (gloves, lab coat, and P-100 respirator) should be donned.

6.5. Spills of nanomaterials should be covered with a wet paper towel or bench paper.

6.6. Clean-up should begin from the outside of the spill and work inward.

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- 6.7. All spill cleanup material should be collected in a leak proof plastic bag and should be disposed through the Chemical Waste Disposal Program.
- 6.8. “Waste Chemicals” label should be placed on the plastic bag and “Nanomaterial Spill Cleanup Material” should be written on the label along with the common chemical name of the nanomaterial.
- 6.9. In the event of a large spill, the spill area should be secured and EH&S should be contacted (412-624-9505).

7. Guidelines for Shipment of Nanomaterials

- 7.1. If nanomaterials are required to be shipped off of the University of Pittsburgh campus via an external shipment company (Ex. UPS or FedEx) then applicable DOT shipping regulations must be followed. Pitt EH&S should be contacted to assist in the shipment of nanomaterials.
- 7.2. If nanomaterials are transported to off campus locations via a personal vehicle, then applicable DOT packaging requirements must be followed. Pitt EH&S should be contacted to assist in determining proper packaging of nanomaterials.

8. Resources

<http://www.cdc.gov/niosh/topics/nanotech/>
<http://198.246.98.21/niosh/docs/2009-125/pdfs/2009-125.pdf>
http://www.osha.gov/dsg/nanotechnology/nanotech_healtheffects.html